AROUND THE LAB

Institute seeks answers to cosmic questions

Editor's note: This is the third article in an ongoing series on the Lab's research institutes. Today's article looks at the Institute of Geophysics and Planetary Physics.

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At first glance, research projects at the Institute of Geophysics and Planetary Physics (IGPP) seem worlds apart. One side of the house studies the Earth's core, while the other is focused on the outer solar system and beyond.

But the pairing of geosciences and astrophysics is long established and well thought out. The fundamental mission of the IGPP is "to promote and coordinate basic research on the understanding of the origin, structure and evolution of the Earth, the solar system and the universe, and on the prediction of future changes as they affect human life."

Kem Cook, acting director of the Lab's IGPP branch, said that astrophysics and geophysics share some basic research thrusts. "They both are trying to understand origins: the origin of the solar system, the origin of structure on Earth and how these evolve," he said.

The IGPP, which was started at the Lab in 1982, is the oldest and most established of the University Relations Program's five institutes, which together form a centerpiece of the Lab's research collaborations with universities. The other institutes are the Institute for Laser Science and Applications, the Institute for Scientific Computing Research, the Center for Accelerator Mass Spectrometry and the Materials Research Institute.

"IGPP has achieved an international reputation as one of the leading research centers in the areas of astrophyiscs and geophyiscs, which allows them to play a strong role in recruiting top research talent to the Laboratory," said Harry Radousky, acting director of the University Relations Program.

IGPP also stands apart from the other institutes because of its unique link to the University of California. It is one of six Multi-Campus IGPP Research Units in the UC system.

The first IGPP was established in 1946 at UCLA. Since then, it has been expanded to UC San Diego, UC Riverside, UC Santa Cruz, Los Alamos National Laboratory and the Lab. Within the next decade, there will most likely be IGPP branches at all UC campuses, Cook said.

"The concept is to have sites at different institutions, which enhance and foster collaborations among the UC campuses and the UC-managed laboratories," Cook said.

"At Livermore, the main purpose of the institute is to foster interactions between the UC campuses and the Lab. It is a window into the Lab, a way to establish collaborations between the campuses and Lab researchers," Cook said. "It has served its purpose quite well."

IGPP researchers have published more than 100 peer-reviewed papers in the last fiscal year. In addition, the IGPP sponsors postdocs at the Lab and currently has about one dozen working on various research projects as well as four graduate students. A number of grad students and college students also work at the institute during the summer.

To stimulate Lab-campus interactions, IGPP awards small grants for research collaborations between principal investigators at the Lab and the campuses, he said. The institute is currently funding about 21 such collaborations with UC campuses.

In total, the IGPP has approximately 40 collaborative ventures with institutions from around the world.

The Lab's institute is divided into two centers: the Astrophysics Research Center, headed by Cook, and the Geosciences Center, led by Rick Ryerson.

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From the left : Kem Cook along with postdoctoral fellow Rodin Porrata and IGPP physicist Stuart Marshall, LLNL members of the Taiwanese American Occultation Survey (TAOS), with one of the 0.5-m TAOS telescopes in Cook's lab in Bldg. 341. Each telescope's performance is optimized at LLNL before being sent to the TAOS observing site in Taiwan where it will search for comets in the outer solar system.

The Astrophysics Center serves as the focus of astrophysics activities at the Laboratory, organizing a weekly seminar series on Friday afternoons, hosting visitors and collaborators, and by editing an annual *Observatory Report* that covers all astrophysics activities at LLNL.

There are a few major research thrusts of the Astrophysics Research Center. One high-profile activity is using adaptive optics systems, which were developed at the Lab to better understand problems ranging from planetary weather and the structure and evolution of satellites around Jupiter, to how black holes in the cores of galaxies interact with the rest of the galaxy. The far reaches of the universe are also being studied.

"The focus here is on the formation of massive galaxies and large-scale structure in the early universe," Cook said.

Current studies use custom-made, narrow-band filters, which are centered on redshifted hydrogen emission-lines. "In the future we hope to use tunable filter instruments such as the Imaging Fourier Transform Spectrometer, which is currently under development at the Lab," Cook says.

There is also a project under way to build a set of four half-meter telescopes for a collaborative project called the Taiwanese American Occultation Survey (TAOS). The four telescopes, which will be located in Taiwan, will all stare at the same portion of the sky, waiting to detect the momentary blinking out of a star due to a comet in the outer solar system passing by — basically waiting for the shadow of a comet, Cook said.

In addition, the Astrophysics center is home of the MACHO (Massive Compact Halo Objects) Project, an international experimental search for the dark matter that makes up at least 90 percent of the mass of our galaxy.

This project has finished collecting data, 7.3 terabytes in 7.5 years, and final analysis is under way. The project brings together researchers from a dozen institutions and has published about 50 papers on the galactic dark matter search, the structure of the galaxy and time variable astrophysical phenomena.

"We are now using the MACHO camera system (an R&D 100 Award winner) to look at the outer solar system — past Neptune — for giant comets or planetismals, objects very similar to Pluto," said Cook, who was one of the founding members of the MACHO collaboration.

The Geosciences Center also serves as the focus for interactions with visitors and academia and industrial and government geoscience research institutions. Its research emphasis has been on the physics and chemistry of the solid Earth, including seismology, geochemistry, experimental petrology, mineral physics and hydrology.

The Geosciences Center is currently sponsoring collaborative research to understand such things as what is happening as the Indian subcontinent collides with Asia, understanding the interaction of the plates and how this interaction is lifting up the Himalayas and the Tibetian plateau, Cook said.

There is also a Geosciences Center project studying meteorite compositions to better understand the formation history of the solar system, which connects topical areas in both centers.

The IGPP has a small core staff located in Bldg. 319. They are primarily dedicated to the Astrophysics Center. The researchers who participate in the Geosciences Center are primarily located in the Energy and Environment Directorate, Cook explained.

"We will continue to act as the main connection point between academia and the Lab for astrophysics and geosciences," Cook said of IGPP's future. "As we move forward and NIF comes on line, both the Institute for Laser Science and Applications and the IGPP will be a significant point of contact for people outside the Laboratory to come do laboratory astrophysics using NIF."

For more information on the IGPP's current research, check the Web at www.llnl.gov/urp/IGPP

The Laboratory concludes its celebration of the 50th annual National Engineeering Week today.